



NOTES AEROBIC RODS

MICROBE OVERVIEW

- Gram-positive, rod-shaped, aerobes/facultative anaerobes

AEROBIC RODS SUMMARY

SPECIES	HOST	TRANSMISSION	PATHOLOGY
BACILLUS ANTHRACIS	Humans, animals	Contact with infected animals; ingestion of contaminated food, water; inhalation; direct injection	Anthrax: cutaneous, respiratory, gastro-intestinal (GI)
BACILLUS CEREUS	Humans, animals	Contaminated food	Food poisoning: diarrheal, emetic syndrome
CORYNEBACTERIUM DIPHTHERIAE	Humans	Aerosol droplets; direct contact with infected lesions/contaminated objects	Diphtheria: respiratory, cutaneous
LISTERIA MONOCYTOGENES	Humans, animals	Ingestion of contaminated food; transplacentally/during delivery	Mild febrile noninvasive gastroenteritis, cutaneous listeriosis, systemic infection

BACILLUS ANTHRACIS (ANTHRAX)

osms.it/bacillus-anthraxis

PATHOLOGY & CAUSES

- Etiologic agent of anthrax; nonmotile, nonhemolytic; potential biological weapon
- Endospore-forming (centrally located)
 - Highly adaptable to extreme environmental conditions
- Surrounded by protein capsule (composed of poly-D-gamma-glutamic acid)
 - Prevents phagocytosis
- Transmission (4 Is)
 - Ingestion
 - Inhalation
 - skin Invasion
 - direct Injection
- Anthrax toxin composed of three proteins
 - Protective antigen (PA): essential for binding, entry to cell
 - Lethal factor (LF): alteration of signaling pathways → cell death; ↑

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proinflammatory cytokines production
→ inflammation

- **Edema factor (EF):** ↑ cyclic adenosine monophosphate (cAMP) → disordered water, electrolyte balance → edema

RISK FACTORS

- Occupational
 - People who work with animals/ animal products (e.g. veterinarians, livestock producers, butchers); possible bioterrorism (e.g. military personnel); laboratory professionals
- Injecting drug users (e.g. heroin contaminated with anthrax spores)

COMPLICATIONS

- Hemorrhagic meningitis, mediastinitis; pleural effusion; pneumonia; shock

SIGNS & SYMPTOMS

- Respiratory infection
 - **Prodromal phase:** flu-like symptoms (e.g. fever, malaise, myalgia), hemoptysis, dyspnea, nausea, chest pain
 - **Fulminant phase:** severe dyspnea, hypoxemia, cyanosis, **shock**, coma
- Gastrointestinal (GI) infection
 - Severe abdominal pain; nausea; vomiting; ascites; ulcerations → GI hemorrhage
- Cutaneous infection
 - **Painless**, pruritic **papule** → enlarges, forms central black-colored **necrotic ulceration** → **black eschar**
 - Surrounding edema
 - Regional lymphadenopathy, lymphadenitis



Figure 55.1 A lesion on the neck caused by *Bacillus anthracis*.

DIAGNOSIS

LAB RESULTS

- Identify microbe
 - Gram stain, culture, direct fluorescent antibody (DFA), polymerase chain reaction (PCR)

OTHER DIAGNOSTICS

- History, physical examination

TREATMENT

MEDICATIONS

- Antibiotics

OTHER INTERVENTIONS

- Vaccine (people at high risk of exposure, post-exposure prophylaxis)

BACILLUS CEREUS (FOOD POISONING)

osms.it/bacillus-cereus

PATHOLOGY & CAUSES

- Common foodborne pathogen; also associated with contaminated medical equipment (e.g. ventilators, dialysis machines), opportunistic infections
- **Endospore-forming** (centrally located)
 - Highly adaptable to extreme environmental conditions
- Motile, catalase positive, beta-hemolytic
- Can be transient component of GI microflora

Pathogenesis of food poisoning

- Production of enterotoxins
 - Diarrheal toxin (thermolabile) → ↑ cAMP → disordered function of ion pumps → ↑ efflux of ions, water from infected enterocytes → diarrhea
 - Emetic toxin, **cereulide** (thermostable) → ↑ afferent vagus nerve stimulation → nausea, vomiting
- Two types of **food poisoning**
 - Diarrheal syndrome (meat, vegetables, sauces) → toxicoinfection → ingestion of bacteria, production of toxins in digestive tract
 - Emetic syndrome (rice) → alimentary intoxication → direct ingestion of toxin

RISK FACTORS

- Consumption of improperly cooked food

SIGNS & SYMPTOMS

- Abdominal cramps, diarrhea, nausea, vomiting

DIAGNOSIS

LAB RESULTS

- Stool/contaminated food sample
- Gram stain
- Culture (blood agar)
- PCR

TREATMENT

OTHER INTERVENTIONS

- Intravenous (IV) fluid, electrolyte replacement

CORYNEBACTERIUM DIPHTHERIAE (DIPHTHERIA)

osms.it/corynebacterium-diphtheriae

PATHOLOGY & CAUSES

- Infectious agent of diphtheria
- Rods with widening at polar regions forming **club-like shape**
- Characteristic “Chinese-letter” arrangement
- Nonmotile, non-spore-forming
- Stain
 - Albert’s/Ponder’s; metachromatic **granules** (e.g. Babes–Ernst, volutin)
- Culture
 - Löffler’s medium
- Differentiation
 - Hoyle’s tellurite agar
- Types of infection
 - Respiratory (pharyngeal), cutaneous

Pathophysiology

- **Diphtheria toxin** → composed of two subunits
 - A: active, catalytic
 - B: binding; composed of R (receptor), T (translocation) domains
- Bacteria binds to host cell using R domain → endocytosis → acidification inside endosome → T domain transfers to endosomal membrane → translocation of A subunit to cytosol
- Subunit A **inactivates elongation factor EF2** → inhibition of protein synthesis → cell death
- Toxin expression regulated by level of iron
 - ↑ Fe → ↓ production of toxin
 - ↓ Fe → ↑ production of toxin

RISK FACTORS

- Absent/incomplete immunization
- Immunocompromised individuals
- Citizens, migrants, returning travellers from endemic areas (e.g. African, Asian, South American countries)

COMPLICATIONS

- Myocarditis, nerve damage (e.g. demyelinating polyneuropathy, paralysis), renal failure, suffocation (due to pseudomembrane aspiration)



Figure 55.2 A pharyngeal pseudomembrane in a child with diphtheria.

SIGNS & SYMPTOMS

- Respiratory infection
 - Sore throat; malaise; low-grade fever; dysphagia; thick, grey, isolated necrotic tissue → pseudomembrane; massive swelling of tonsils, cervical lymph nodes → “bull neck”; stridor
- Cutaneous infection
 - Lesions, pain, rash, tenderness, erythema, ulceration

DIAGNOSIS

LAB RESULTS

- Gram stain
- Culture
- Elek test (differentiation of toxigenic strains)
- PCR

OTHER DIAGNOSTICS

- History, physical examination

TREATMENT

MEDICATIONS

- Diphtheria antitoxin
- Antibiotic

OTHER INTERVENTIONS

- Prophylaxis
 - Young children: diphtheria-tetanus-acellular pertussis (DTaP) vaccine
 - Adolescents/adults: tetanus-diphtheria (Td)/tetanus-diphtheria-pertussis (Tdap) vaccine



Figure 55.3 An ulcerating skin lesion on the leg caused by cutaneous diphtheria.

LISTERIA MONOCYTOGENES

osms.it/listeria-monocytogenes

PATHOLOGY & CAUSES

- Facultative intracellular bacteria, anaerobe; beta-hemolytic
- Capable of growing at refrigeration temperatures (0–4°C/32–39.2°F)
- Motile
 - ≤ 30°C/32°F (flagella); body temperature (comet tail structures, polymerized host cells actin)
- Foodborne pathogen, common cause of bacterial neonatal meningitis

Pathophysiology

- Listeria enters host cell via zipper mechanism → bacterial protein internalin binds onto cell membrane protein cadherin → releases listeriolysin O → disruption of vacuolar membrane → invasion of cytosol → actin assembling-inducing protein → polymerisation of cytoskeleton → bacteria gains motility → rapid movement through cytosol, between cells

RISK FACTORS

- Mild febrile gastroenteritis
 - Immunocompetent individuals, ingestion of contaminated food (e.g. raw meat, unpasteurized dairy, seafood)
- Cutaneous infection
 - Direct inoculation of skin (e.g. veterinarians, farmers handling infected animals)
- Invasive listeriosis
 - Immunocompromised individuals, age (neonates, elderly), pregnancy

COMPLICATIONS

- Immunodeficient, elderly individuals
 - Sepsis, meningitis, encephalitis, pneumonia, corneal ulcer

- Pregnant individuals
 - Neonatal meningitis, granulomatosis infantiseptica, miscarriage, stillbirth, premature delivery with chorioamnionitis

SIGNS & SYMPTOMS

- Previously healthy individuals
 - Fever, headache, diarrhea, vomiting, nausea, pustular skin lesions
- Individuals with weakened immune system
 - Stiff neck, confusion, convulsions, loss of balance, cranial nerve palsies
- Pregnant individuals
 - Nonspecific flu-like illness
- Newborns
 - Low birth weight, irritability, fever, poor feeding, circulatory/respiratory insufficiency, pyogranulomatous lesions

DIAGNOSIS

LAB RESULTS

- Culture
 - Blood, cerebrospinal fluid (CSF); cervix, amniotic fluid in pregnant individuals; meconium, gastric aspirate, infected tissues (e.g. skin granulomatous lesions) in newborns

OTHER DIAGNOSTICS

- History, physical examination

TREATMENT

MEDICATIONS

- Antibiotics (e.g. ampicillin, penicillin G, gentamicin)